Department of Ocean and Mechanical Engineering
Florida Atlantic University
Course Syllabus

1. Course title/number, number of credit hours	
EOC 6189 – Computational Fluid Dynamics	3 credit hours
2. Course prerequisites, corequisites, and where the course fits in the program of study	
Prerequisites: Instructor's permission. Knowledge of basic Fluid Mechanics and Ordinary/Partial Differential Equations expected. Programming experience required in *any* of the following languages: Matlab *or* Python *or* Fortran *or* C/C++.	
3. Course logistics	
Term: Spring 2019 *Class location and time*: SeaTech 209 / CM 125 / Distance Learning Tues/Thurs 11:00am-12:20pm	
4. Instructor contact information	
Instructor's name *Office address* *Office Hours* *Contact telephone number* *Email address*	Siddhartha Verma Seatech 235 MW 3:30 – 4:30 PM ST 235 (or by Appointment) 954.924.7202 vermas@fau.edu
5. TA contact information	
N/A	N/A
6. Course description	
A systematic introduction of computing techniques for fluid flow, including fundamentals of computational fluid dynamics, finite difference methods for incompressible flow, finite volume method, implicit and explicit time integration schemes, stability analysis, Poisson solvers, and immersive data visualization. The course consists of homework sets and projects involving extensive hands-on programming.	
7. Course objectives/student learning outcomes/program outcomes	
Course objectives	The objective of this course is to introduce the fundamentals of computational fluid dynamics using a balanced combination of theory and practice. The emphasis will be on understanding the basics of numerical methods, and the integration of stand-alone components to form a fully functional flow-solver. At the end of the course, the students will have gained sufficient experience to be able

	to make informed decisions when writing customized software, as well as for using existing open-source/commercial codes.
Student learning outcomes & relationship to ABET 1-7 objectives	A general understanding of the following topics: 1. Numerically solving Ordinary and Partial Differential Equations. 2. The ability to use version control software and immersive data visualization. 3. Conservation laws (Navier-Stokes equations) and their discretization in space and time. Appropriate numerical schemes to use in various scenarios. 4. Numerical differentiation and integration. Grid- & time-convergence, their relation to truncation error of discretization schemes. Stability of numerical schemes.

8. Course evaluation method

Homework 30% Projects 70% Extra Credit 10%	There are no tests/exams in this course. The final grade is assigned based on homework and projects. All assignments will be available/submitted online on Canvas. Students may earn up to 10% extra credit by completing the Extra Credit Project.

9. Course grading scale

A	> 90%	C+	65 – 69.9
A-	85 – 89.9	C	60 – 64.9
B+	80 – 84.9	C-	55 – 59.9
B	75 – 79.9	D	50 – 54.9
B-	70 – 74.9	F	< 50

In case the final class average is lower than a 'B-', the grades will be adjusted upward using a bell-curve.

10. Policy on makeup tests, late work, and incompletes

Late work will not be accepted unless there is solid evidence of a medical or otherwise serious emergency that prevented the student from completing the assignments on time. Incomplete grades are against the policy of the department. Unless there is solid evidence of medical or otherwise serious emergency situation, incomplete grades will not be given

11. Special course requirements

12. Classroom etiquette policy

University policy requires that in order to enhance and maintain a productive atmosphere for education, personal communication devices, such as cellular phones and laptops, are to be disabled in class sessions.

13. Disability policy statement

In compliance with the Americans with Disabilities Act Amendments Act (ADAAA), students who require reasonable accommodations due to a disability to properly execute coursework must register with Student Accessibility Services (SAS)—in Boca Raton, SU 133 (561-297-3880); in Davie, LA 203 (954-236-1222); or in Jupiter, SR 110 (561-799-8585) —and follow all SAS procedures.

14. Honor code policy

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high quality education in which no student enjoys unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and place high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. See University Regulation 4.001 at www.fau.edu/regulations/chapter4/4.001_Code_of_Academic_Integrity.pdf

15. Counseling and Psychological Services Center

Life as a university student can be challenging physically, mentally and emotionally. Students who find stress negatively affecting their ability to achieve academic or personal goals may wish to consider utilizing FAU's Counseling and Psychological Services (CAPS) Center. CAPS provides FAU students a range of services – individual counseling, support meetings, and psychiatric services, to name a few – offered to help improve and maintain emotional well-being. For more information, go to http://www.fau,edu/counseling/

16. Required texts/reading

Essential Computational Fluid Dynamics, by Oleg Zikanov
(Note: **Free digital copy** available through the FAU library).

17. Supplementary/recommended readings

Finite Volume Methods for Hyperbolic Problems, by Randall J. LeVeque
(Note: **Free digital copy** available through the FAU library).

Computational Fluid Dynamics: The basics with applications, by John D. Anderson

18. Course topical outline, including dates for exams, papers, completion of reading

Note: The instructor may modify this list to suit in-class progress.

Week	Date	Topic
1	8-Jan 10-Jan	Discretizing ODEs & PDEs. Conservation Laws.
2	15-Jan 17-Jan	Version control. Visualization. High order Finite Differences.
3	22-Jan 24-Jan	Navier-Stokes equations in three dimensions. Operator Spllitting.
4	29-Jan 31-Jan	Pressure projection method. Time integration schemes.
5	5-Feb 7-Feb	Initial and Boundary Conditions. Dispersion and Dissipation errors.
6	12-Feb 14-Feb	Fluid-solid interaction.
7	19-Feb 21-Feb	Staggered vs. Co-located grids. Solution of Parabolic, Elliptic, and Hyperbolic equations.
8	26-Feb 28-Feb	Finite Volume methods. Shocks, expansion fans, flux limiters.
9	5-Mar 7-Mar	**Spring Break – No classes**
10	12-Mar 14-Mar	Approximate Riemann Solvers.
11	19-Mar 21-Mar	Vortex methods. Semi-Lagrangian transport.
12	26-Mar 28-Mar	Freespace Green’s function. FFT based solution. High Performance Computing.
13	2-Apr 4-Apr	Spectral methods.
14	9-Apr 11-Apr	Non-uniform grids.
15	16-Apr 18-Apr	Turbulence modelling. Large Eddy Simulation, Reynolds Averaged Navier-Stokes.
16	23-Apr	Reserve class time. **Final Project due.**